FOLDABLE ELECTRONIC DEVICE AND A FLEXIBLE DISPLAY DEVICE

TECHNICAL FIELD OF THE INVENTION

The invention relates to an electronic device. In addition, the invention relates to a flexible display device for an electronic device.

BACKGROUND OF THE INVENTION

The use of large area displays in foldable electronic devices is becoming increasingly interesting and this also creates growing interest towards different kinds of flexible display devices. Some solutions have been presented, inter alia, in U.S. Pat. No. 6,377,324, where the folding of a flexible display device has been taken into account; in U.S. Pat. No. 6,577,496, where the flexible display device is able to move; and in US 2004/0052044 A1, where a hinge system of an electronic device facilitates the flexing of a display device and the closing of the electronic device.

The manufacture, materials, structure and operation of flexible display devices are known as such in such respects how, for example, the structure allows the folding of a display device, as disclosed in US 2004/0159710 A1 and U.S. Pat. No. 6,016,176, or the rolling of a display device, as disclosed in U.S. Pat. No. 4,948,232, WO 2004/047059 A1 or US 2004/0061683 A1. The display device is based on, for example, LCD technique (Liquid Crystal Display) and they have been applied, inter alia, in mobile phones, as disclosed in WO 2004/001704 A1, US 2002/0090980 A1, U.S. Pat. No. 6,771,232 B2 or U.S. Pat. No. 6,311,076 B1.

In foldable electronic devices, such as wireless terminals, mobile phones and PDA devices (Personal Digital Assistant) the use of flexible display devices is problematic, when an integral display device is located twofold between the parts of an electronic device and covers the different parts of the opened electronic device. The electronic device is easy to close by folding the parts against each other, because the flexible display device may naturally tend to fold twofold. In the folded position said tendency is removed or decreases significantly, but in the open position of the electronic device, the above-mentioned effect may be directed towards the display device as a continuous tension. In addition to this, the phenomenon in question may limit the implementation possibilities of the electronic device, because its effect must be compensated in the construction of the hinge structure in order for the electronic device not to tend to close by itself. Lockings must possibly be added to the hinge or the device must be manually prevented from closing itself. Further, complex mechanical support arrangements are often required to ensure that the folding display remains flat and therefore easy to read when the device is opened.

SUMMARY OF THE INVENTION

The aim of the invention is eliminating said problems related to flexible display device and enabling their easy applicability in foldable electronic devices. By means of the flexible display device it is possible to utilize the folding point of the device or the area above the hinge as well for display purposes. By means of the invention, a display is also created, which is larger in area than an individual part of the electronic device. An example of an electronic device is a device composed of two or more foldable parts, which is, for example, a wireless terminal or a mobile phone, equipped possibly with personal data processing properties or data transfer properties.

According to one embodiment of the invention, the flexible display device has one or more states, which is represented by a preferred position or form, which the flexible display device tends to set itself to. In one embodiment the flexible display device naturally tends to remain open in a position where it covers as wide as possible an area. At the same time, the display device is curved in a direction that is substantially perpendicular to such a direction where the flexible display device itself tends to fold to or to where it is folded twofold. The display device according to the invention deviates from a rolling type display, instead it merely tends to fold. Advantageously the display device has two states, which it tends to prefer: the above-mentioned curved and rigid position and a position where the profile of the display device is straight but twofold. Thus, the display device has two states, where the prevailing tensions are different. The curved position occurs in different embodiments either as a concave or a convex state, where said cross-sectional shape of the display foil also stiffens up the display structure. According to an embodiment, in the case of a foldable electronic device, the flexible display device tends, at least at the swivel or the possible hinge of the device to fold twofold into a closed position. The tendency to move to a curved open position also occurs at the corresponding point. According to an embodiment, the tendency to move to a curved position is invoked by an external stimulus. In an embodiment, the stimulus is achieved by means of an organ or body placed in the electronic device, which is controlled mechanically or electrically. In an embodiment the above-mentioned organs also assist in straightening the display device for the folding.

In some embodiments the opposite ends of the flexible display attach to two adjacent parts of the electronic device. The parts of the device are moved to an angular position and the flexible display straightens between them, in which case a display is created, which is larger in area than an individual part.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the invention will be described in more detail with reference to the appended drawings, in which

FIG. **1** shows a foldable electronic device in a closed position and a folded flexible display device,

FIG. **2** shows the foldable electronic device of FIG. **1** in an open position and a curved flexible display,

FIG. **3** shows a top view of the foldable electronic device of FIG. **1** in an open position and its uncovered hinge structure,

FIGS. **4** & **5** show end views of the foldable electronic device of FIG. **1** in an open position and a curved flexible display,

FIG. **6** shows a top view of a foldable electronic device in an open position and its uncovered hinge structure,

FIGS. **7** & **8** show end views of a foldable electronic device in an open position and a curved flexible display,

FIG. **9** shows a top view of a foldable electronic device in an open position and a flexible display device assembled to it,

FIGS. **10** & **11** show side views of a foldable electronic device in an open position and a curved flexible display,

FIGS. **12** to **16** show side views of a foldable electronic device in a closed position and a folded flexible display, and

FIG. **17** shows a side view of a foldable electronic device in an open position and a curved flexible display.

DETAILED DESCRIPTION OF THE INVENTION

The electronic device **1** shown in the figures is shown in such respects that are necessary for visualizing the invention.